COMMON CONNECTICUT FLIES

Robert C. Wallis

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Notice

The accompanying publication, printed some years ago, contains descriptions and biological information, and suggestions for control by spraying. It suggests the use of DDT.

Present regulations of the State Board of Pesticide Control restrict use of DDT by custom spray operators for this purpose.

Carbaryl (Sevin®) or lindane may be used to control these pests.

May 1, 1967

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION

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Acknowledgment

The author thanks Hedwig Streng, who made the drawings reproduced in Figures 2 through 14 of this publication. Dimensions given in the captions are approximate and refer to length of the flies, life size.

COMMON CONNECTICUT FLIES

Robert C. Wallis

Among the insects in Connecticut, those in the order Diptera, or flies, are very prominent. There are many kinds of true flies and mosquitoes; over 73,000 species are known in the world. Only a few of these are commonly found in Connecticut. Among these few, however, are some of the most bothersome and dangerous insect pests of man and domestic animals in the State. The flies are so varied that entomologists classify them in four major groups or Suborders. The different species and genera are further grouped in Families of the Suborder as follows:

The Taxonomic Groups

Class Insecta. 1. Suborder—Nematocera. This group includes the following families of flies: Tipulidae (crane flies), Psychodidae (moth flies and sand flies), Culicidae (mosquitoes), Ceratopogonidae (biting midges), Simuliidae (black flies), and Anisopodidae (window gnats).

2. Suborder—Brachycera. This group includes the families Rhagionidae (snipe flies) and Tabanidae (horse flies and deer flies).

3. Suborder—Cyclorrhapha. This large group includes the families of flies named Phoridae, Syrphidae (the flower flies), Drosophilidae (fruit flies), Chloropidae (eye flies), Sepsidae, Piophilidae (cheese skipper), Gastrophilidae (horse bot flies), Calliphoridae (blow flies), Muscidae (house flies and stable flies), and Oestridae (warble flies).

4. Suborder—Pupipara. In this group the family Hippoboscidae (tick flies and louse flies) is found.

The Culicidae (mosquitoes) in the State have already been discussed in Bulletin 632, Mosquitoes in Connecticut (14). Other groups that include the mosquito-like flies—the "moth flies," "crane flies," "gnats" and "midges"—will be discussed elsewhere. Only those more commonly regarded as household pests will be discussed here, along with some of the common flies that people frequently encounter out of doors.

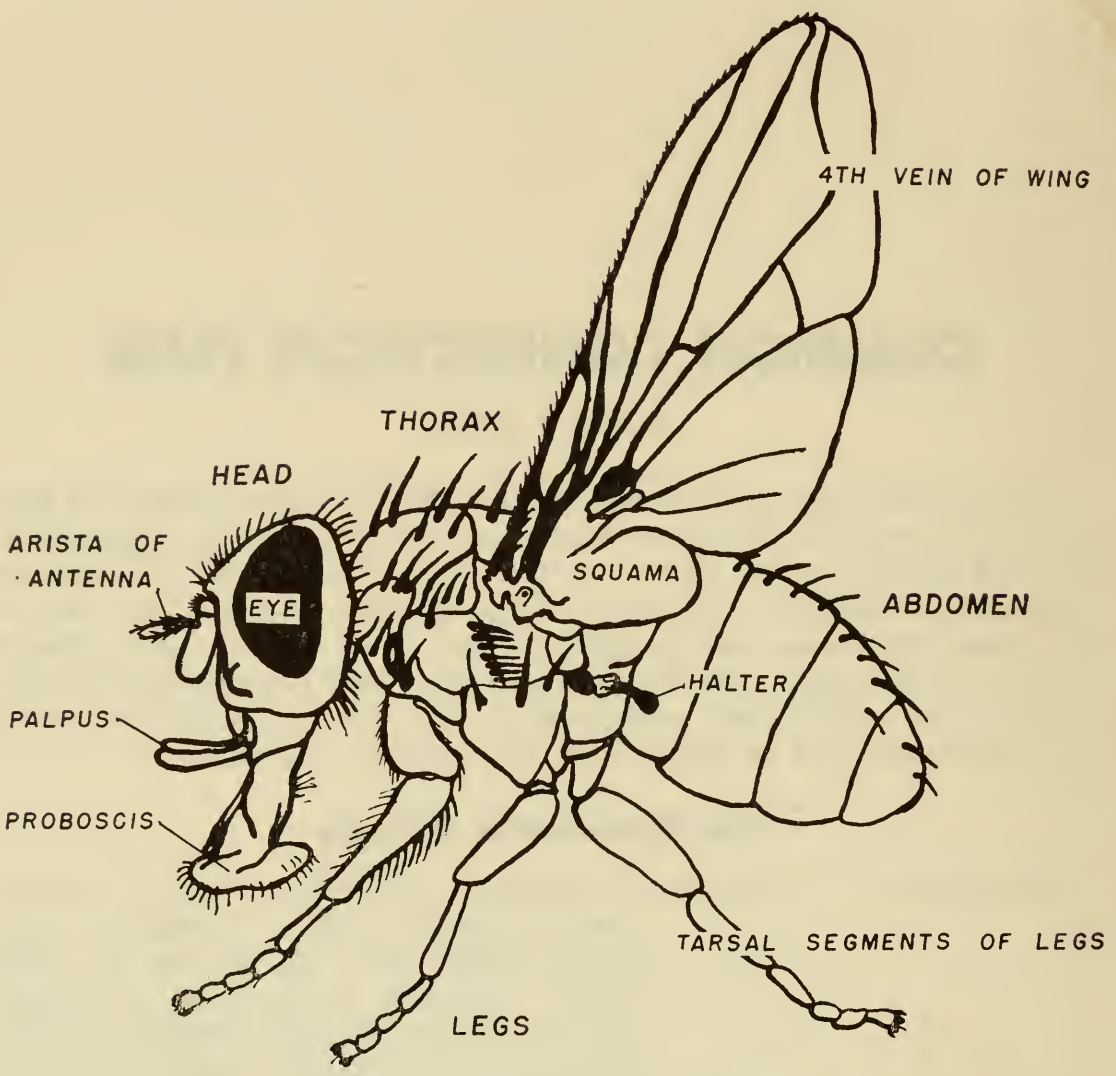

Figure 1. Parts of the house fly.

Basic Structure of Flies

The body of the fly is composed of three main parts: the head; the thorax, or central portion, with three pairs of legs and one pair of wings; and the abdomen of five segments (Fig. 1). While the most conspicuous feature on the head is the pair of relatively enormous compound eyes, the pair of antennae and the mouthparts, or beak, are of more taxonomic and practical significance. The antennae are located in the front of the head between the eyes (as shown in Fig. 1) and are sensory organs.

The mouthparts extend from the lower portion of the head and may be either of the biting type or of the non-biting structure as shown in Fig. 2. The biting flies have a rigid beak containing the labium, which forms the piercing organ. This normally projects forward when not in use. The labium of non-biting flies consists of a soft fleshy structure suspended from the lower part of the head. It may be retracted or extended at will and is normally carried folded up close under the head. The broad, flattened, pin cushion-like labellum at the tip of the proboscis is not capable of piercing the skin, although on some species of

flies there are spines and teeth that can scrape when the labellum is used in a rasp-like fashion.

The thorax, or middle portion of the fly's body, is composed of three segments, each of which bears a pair of legs. Only the middle or largest thoracic segment, however, is adorned with wings. On each side of the fly's thorax, in addition to the centrally located wings, there are two spiracles, or breathing holes. Below the wing there is located another projecting structure, the halter, that is actually an undeveloped wing. This is utilized by the fly as a balancing organ.

The two wings, one on each side of the fly, are composed of a large transparent membrane stiffened by rigid wing veins. At the base of each wing is a small hairy plate-like projection that looks like a flap. It is usually called a tegula, squama, or calypter (Fig. 1).

From the lower portion of each thoracic segment a pair of legs projects. Each of these six legs is made up of eight parts, or movable sections; the coxa, femur, tibia, basitarsus, and four tarsi. At the tip of the leg, or last tarsal segment, a special claw is formed by two stout, bent spines, a central hook-like empodium, and two hairy adhesive pads or pulvilli.

The relatively large abdomen of the fly is composed of cylindrical segments. The posterior tip contains the genital structure of the male or female fly, but these organs are usually retracted out of sight and there is little superficial difference between sexes.

The most remarkable feature of the external morphology of the fly is the variety of types of spines and hairs in the body covering. These range from strong sharp pike-like spines, used for protection and for grasping ob-

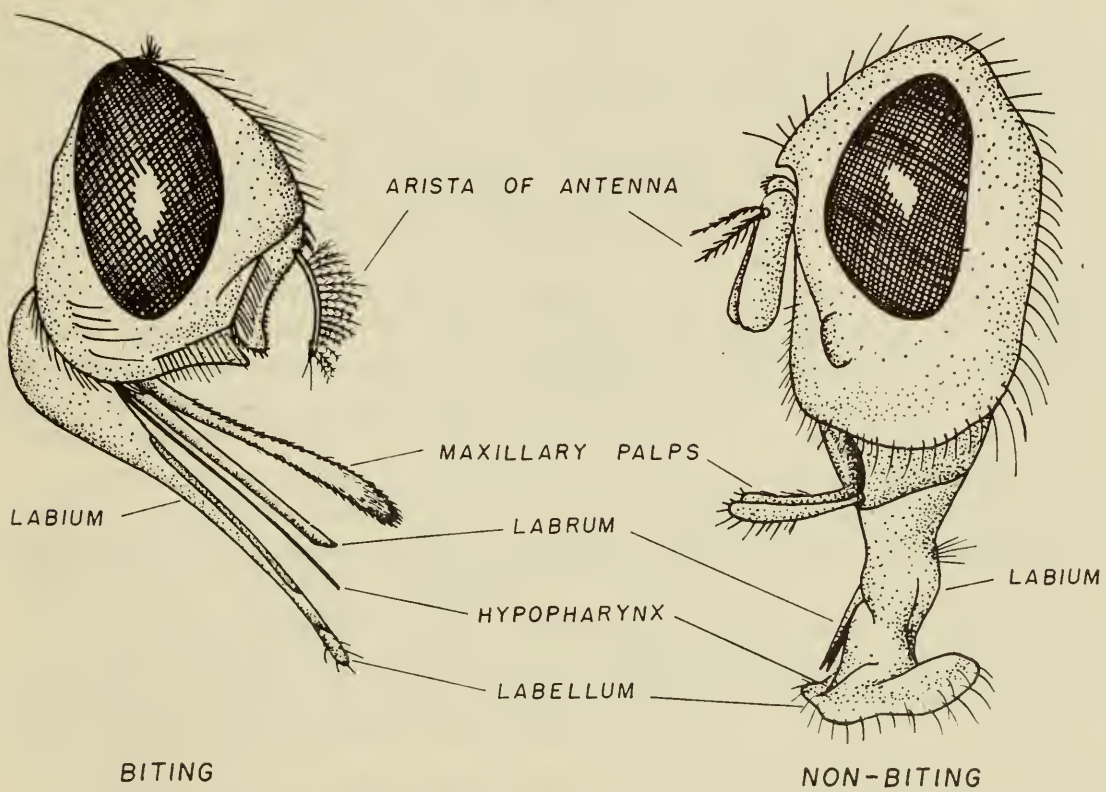

Figure 2. Mouth parts of a biting fly and a non-biting fly.

jects, to fine sensitive hairs and thin-walled spines that are really special sensory organs. Some of these on the tarsi of the legs, proboscis, and antenna are chemosensitive taste- and odor-detecting spines. The fine hairs, or aristae, of the antenna are very sensitive to air pressure changes and enable the fly to escape crushing by falling objects. This sensitivity is what often enables the fly to evade the fly-swatter.

Life Cycle of a Fly

Discussion of the flies should contain a brief review of the biology and life history of the house fly, *Musca domestica,* because it is still commonly believed by many, even well-informed people, that *little* house flies grow up to become *big* house flies! Such a belief is not difficult to understand when one examines the number of different sized species, all somewhat similar in appearance, that occur in and around houses.

Flies, like other insects, do not grow in size as they age, but pass through four distinct stages in their life cycle. This cycle begins when the female fly deposits eggs, often as many as 150 in one egg-laying period. One fly may oviposit from several to as many as 20 or more batches of eggs, totalling over 2,000 eggs in one season.

The female fly usually deposits eggs on media suitable for food, and when the eggs hatch after 6 to 12 hours, the larvae (maggots) begin feeding. The wedge shaped worm-like maggot tapers to a rudimentary head armed with a pair of mouth hooks (Fig. 3). After the larva grows through three developmental stages within a period of about 1 week, the fully-grown maggot crawls away from the moist breeding medium to a drier place and forms a pupa. In forming this pupal stage, the larval skin shortens, the ends round off, and the skin hardens, developing into a dark brown puparium. Within this protective case, during a 3- to 4-day period, the worm-like maggot develops into an adult fly.

When the adult fly is ready to emerge, the body fluids are forced into the head, resulting in a bubble-like expansion that forces an opening in the end of the pupal case through which the fly escapes. During the first day the new adult fly recovers from the rigors of extracting itself from the pupal case, and mating occurs. Within 3 days the female is ready to lay eggs. For this purpose the fly seeks out suitable breeding media such as deposits of fecal material. The manure pile has always been a principal source of house flies in rural areas, but other decomposing organic material, especially high protein stock feed that has become moist, provides an excellent medium.

In urban areas the garbage dumps, garbage cans, dog feces, scraps of food, seepage from faulty septic disposal systems, grease-soaked soil around rendering plants, debris under restaurant and food store loading platforms, privies and stables all provide excellent breeding sites.

When food and breeding places are close at hand, the house fly seldom travels far. When they are scarce, however, the fly may search over long distances. Therefore, one highly infested breeding site may provide house flies for an entire community.

Complete details of the biology of the house fly are presented in the excellent book by West (13) that summarizes the entire subject.

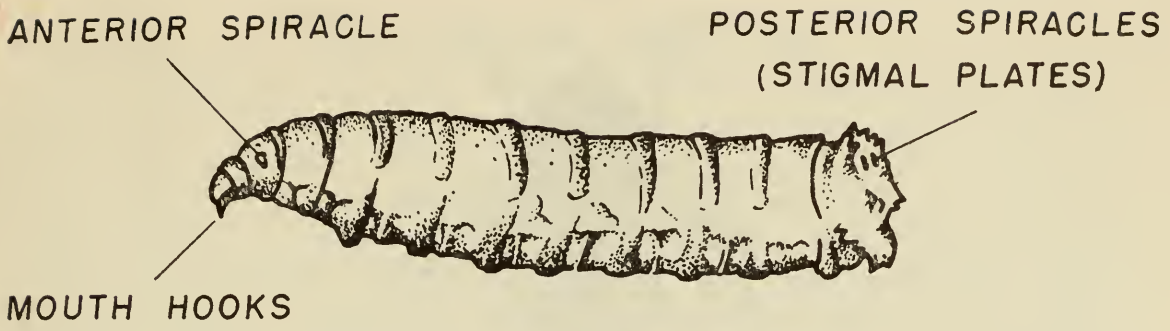

Figure 3. Mature maggot or larva of house fly. Life size is about ¼ inch long.

PEST FLIES

The vast majority of flies encountered by people in Connecticut are in two main groups, those that enter the house and those that are pests in the yard and garden. In the former group *Musca domestica,* the common house fly, is the chief pest. It will be discussed first, along with several other species of similar appearance that often enter the house and are generally mistaken for house flies.

The second group of flies most often encountered by the homeowner is composed of those that only occasionally enter houses, but are the principal pests outside in the yard and garden. These are the blow flies and flesh flies, that have become increasingly significant in recent years, as residential communities spread out into the suburban areas.

Common Household Pest Flies

Musca domestica, the common house fly, is medium in size (about ¼ inch long) and greyish in color. The head is straw-colored with brown antennae and black mouthparts. On the top of the thorax are four distinct longitudinal black stripes that aid in identification. Another characteristic is the sharp bend frontward of the fourth wing vein out near the tip of the wing, as shown in Fig. 1 and Fig. 4.

In the springtime, the female fly comes out of protected hibernation places, such as attics and cellars, to seek food and breeding places. With the onset of warm weather in the springtime and early summer, the fly population builds up rapidly, since the entire developmental cycle may be completed within a little over 1 week.

As mentioned before, one female house fly under favorable conditions (plenty of food, larval breeding places, and warm temperatures) may lay many batches of eggs. The high reproduction rate is the most significant aspect of the house fly biology.

Several other kinds of flies are abundant and commonly enter houses, particularly in suburban residential and rural areas. Most of these are frequently mistaken for the house fly, because they are generally about the same size and color.

Fannia canicularis, the lesser house fly, and *Fannia scalaris,* the latrine fly, both frequent houses. While they are somewhat smaller than the

Figure 4. *Musca domestica,* house fly. ¼ inch.

house fly, the size difference is not sufficient to be a distinguishing characteristic. The fourth wing vein of both, however, is not bent sharply as is that of *M. domestica;* it extends almost straight out to the edge of the wing. Both of these flies breed in places similar to those utilized by house flies, but they prefer less moist media. The drying excrement from dogs and cats in the suburban neighborhood provides an excellent food and breeding medium. In rural areas the drying feces under roosts in chicken houses provide breeding sites for either of these species and are therefore a common source of trouble. The adults of *F. canicularis,* once they have gained entrance into the house, are perhaps not as bothersome as the common house fly since they tend to hover and fly about rather than settle upon human food.

Muscina stabulans, the nonbiting stable fly, resembles the house fly in that it has four dark longitudinal lines on the thorax. The fourth wing vein, however, is quite different and curves only slightly forward in a shape distinct from *M. domestica. Muscina stabulans* is also found in houses, barns, and garages—often in annoying numbers. It breeds in a variety of organic material such as manure and decaying garbage. *M. stabulans* is more common in rural and suburban communities than *M. domestica.*

Musca autumnalis, the face fly, has become established sufficiently in Connecticut to rank among the household pest flies that annoy the homeowner. It is most abundant in rural and outlying suburban areas near dairy farms. It breeds preferentially in cow dung and is a pest primarily on and about the faces of cattle, hence the name face fly. This particular habit makes it a great source of annoyance to cattle. *M. autumnalis* looks so much like *M. domestica* that it is difficult to differentiate between the two without some experience with known specimens. The face fly, however, has more grey area between the eyes; this area in the house fly is a yellowish-grey color, rather than grey-white.

Perhaps because of the trend in recent years for residential communities to extend into suburban areas and because of the extent of the dairy industry in Connecticut, the face fly has often been found among the flies collected in houses, primarily in the fall season when the flies begin to seek sheltered places for overwintering.

Blow Flies and Flesh Flies

The well-known blue bottle flies, green bottles or blow flies are representatives of the family Calliphoridae. They comprise a large portion of the pest fly problem in much of suburban Connecticut. In addition to their pestiferous nature, some of the species in this group are of public health concern; the green bottle flies (*Phaenicia*) and the black blow fly (*Phormia*) have been known to carry the virus of poliomyelitis. While the significance of these flies in the epidemiology of polio and other enteric viruses is not fully understood, the blow flies are receiving increased attention. Because of the similarity of many species of the common blow flies, students are urged to consult the excellent article, "Identification of Common Flies" by H. R. Dodge, published in *Public Health Reports,* March, 1953 (7), and books by Hall (9) and James (10).

Some of the large blow flies or blue bottle flies in the genus *Calliphora* pose a special problem in that the identification of most species in this group is difficult. The two most common ones, however, can be recognized by the coloration of the checks and head. *Calliphora vicina* (formerly called *erythrocephala*) (Fig. 5) has checks of a reddish brown color and has brown-colored anterior spiracles. The other common species, *Calliphora vomitoria,* has a fringe of yellow-brown colored hairs on the lower hind margin of the head. These species are common in the Northern Hemisphere and occur in the greatest numbers during the spring and fall. The eggs are deposited on dead animals and decaying meat that serve as food for the developing larvae. The flies have also been known to oviposit in open wounds or ulcers of animals and occasionally of man. The blow flies are most frequently seen around the home in yard and garden. Meat scraps in garbage cans, dog and cat droppings, and dead birds and rodents are particularly attractive breeding material.

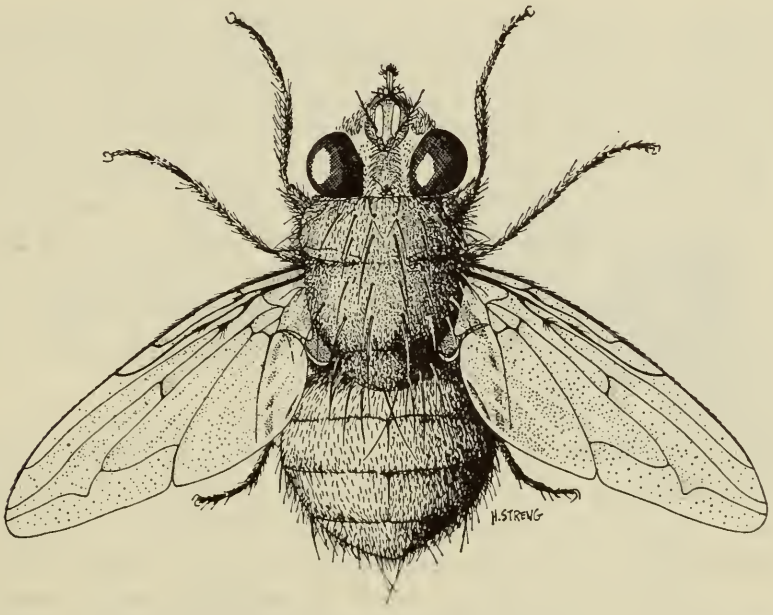

Figure 5. *Calliphora vicina,* blow fly. ½ to ¾ inch.

Figure 6. *Phaenicia sericata,* green bottle fly. ¼ inch.

Phaenicia sericata, the green bottle fly is, as the common name implies, metallic-green in color (Fig. 6). It is about the size of the common house fly, but smaller than the blue bottle fly, *Phormia regina.* Unfortunately the identification of the green bottle fly is not as simple as it sounds because some of the other blow flies have metallic green body coloring (*Lucilia illustris* and *Bufolucilia silvarum*). *P. sericata* is the most common species, but is variable in body color, ranging from the usual green to a blue, and occasionally copper red luster. However, *P. pallescens* that is most often mistaken for *P. sericata* is more prevalent in the southern United States than in Connecticut. Here, *P. sericata* is primarily an urban species and breeds most frequently in backyard garbage cans, market districts, and city dumps.

Another green bottle fly, *Lucilia illustris,* is very similar to *P. sericata* in appearance and habits. It breeds in dead animal matter and garbage cans, but is more common in rural and suburban residential areas than *P. sericata.* The closely related *Bufolucilia silvarum,* which is known to be a parasite of toads and frogs, also has a rural and suburban-woodland distribution.

Phormia regina is deceptively called the black blow fly but its body is not black. Rather, the color is a dark metallic green or green-blue. It may be separated from the similar *Phaenicia* by the presence of red-brown (rather than black) colored anterior spiracles. *Phormia regina,* like the other blow flies, breeds in dead animal matter, garbage, and city dumps. It is more prevalent in the fly population during the spring and fall seasons than other blow flies. This fly has been shown to be a good host of the poliomyelitis virus. In the laboratory the virus persisted within the fly during an experimental 3-month hibernation period. Therefore, *P. regina* is currently considered as a possible extra-human reservoir of the poliomyelitis virus.

The *Sarcophaga,* or flesh flies, are frequently observed about garbage cans and decaying animal matter. There are many species in this group, and they vary from very small flies, less than ¼ inch, to large robust flies that are over ½ inch in length. They are usually recognized by the presence of three black stripes on the top of the grey thorax. The abdomen typically has a "checkered" pattern of dark and light areas usually lacking on other flies.

The biology of the flesh fly is somewhat different from that of the house fly and blow fly. Instead of depositing eggs, the adult female deposits newly-hatched living larvae. This characteristic enables the fly to implant tiny maggots in sores and abrasions on man and animals, so that an infestation can become established within a matter of minutes. On rare occasions the larvae have been known to invade the nasal cavities and intestinal tracts of man and animals. The book by Aldrich (1), *Sarcophaga and Allies in North America,* gives keys for identification and specific details that students interested in *Sarcophaga* will find valuable.

COMMON BITING FLIES

Flies in the family Tabanidae are known to most of the people in Connecticut because of the blood-sucking behavior of the female fly in two genera. Those in the genus *Tabanus* are commonly called horse flies, while the smaller, banded-winged ones in the genus *Chrysops* are known as deer flies. The horse flies are more troublesome pests of livestock, but deer flies cause greater annoyance to human beings.

Horse Flies

Several species of the Tabanidae are common in Connecticut (see reference 8) because of the abundance of semi-aquatic breeding places. The eggs, massed in clumps, are laid on foliage, rocks, or sticks above the surface of the water in ponds, swamps, pools, and streams. The larvae hatch from the eggs and fall into the water where they grow through the immature stages. This aquatic larval stage is sometimes quite long, as much as 3 years. Upon completion of the larval development, the larvae crawl out of the water to adjacent soil, well above the water line, and

Figure 7. *Tabanus atratus,* horse fly. 1 inch.

burrow several inches into the moist earth. From this buried pupa the newly developed fly emerges and makes way to the open air for its adult life "on the wing."

The large horse fly, *Tabanus atratus,* is almost an inch in length (Fig. 7). These flies are characterized by their stout appearance, the unusually large head, the special venation of the wings, the large brilliantly-colored eyes, and the special structure of the antennae. The mouthparts are developed for piercing, but only the females feed on man and animals. The male flies feed on plant nectar. The horse fly is most irritating to horses and cattle on warm, humid days when the biting activity is most intense.

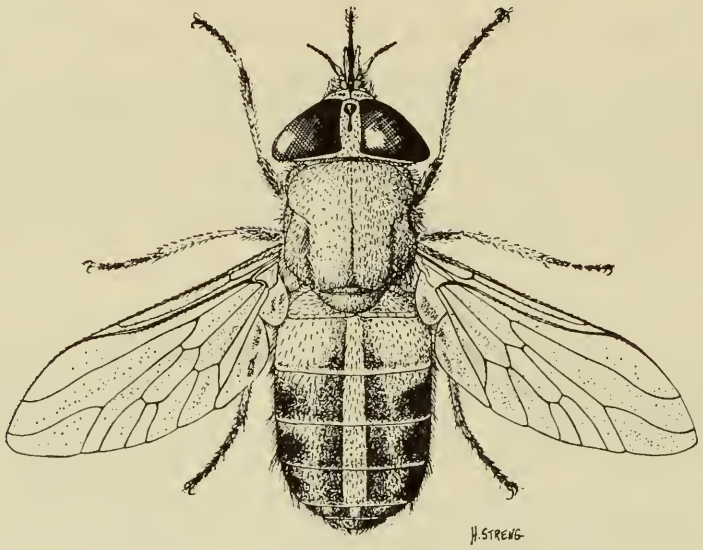

Figure 8. *Tabanus nigrovittatus,* horse fly. ½ inch.

A much smaller horse fly, *Tabanus nigrovittatus,* is shown in Fig. 8. It is perhaps more common in Connecticut than the large *T. atratus* and is more likely to be annoying to man. Fortunately, it is less than one-half the size of *T. atratus.* It is similar in size and color to the deer fly, *Chrysops callida,* shown in Fig. 9. While the brown and yellow coloring of the bodies of the two flies are somewhat similar, the deer fly has "pictured" wings. This distinctive color pattern on the wings and the fly's persistence in attacking man leaves little doubt about the identity of the deer fly in Connecticut.

Of all the biting flies in Connecticut, the deer fly is perhaps the most annoying to man. The deep piercing bite of the fly is painful, and the flies are persistent in their attack. While in the act of sucking blood the fly is easily disturbed and flies away, but quickly returns to bite in another place. The deer flies that bedevil swimmers are known as green-heads. Many bathers have experienced the frustration of trying to avoid the stinging attack of the tenacious green-head. Exasperated swimmers have retreated to deep water and submerged completely in evasion attempts, only to find that when they come back up to the surface, the tireless deer fly is buzzing around waiting to renew the attack. As recreation facilities around the many lakes and shore areas in the State become more popular,

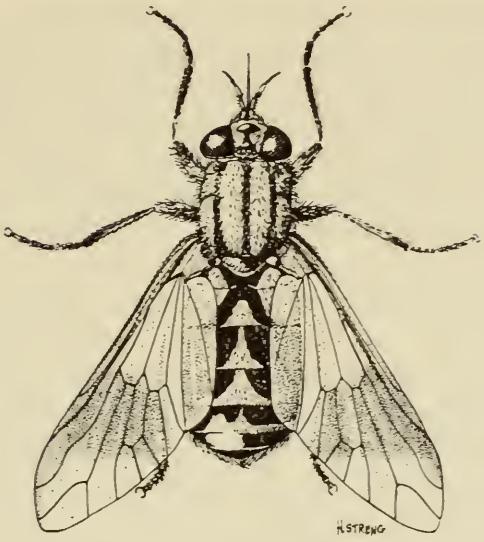

Figure 9. *Chrysops callida*, deer fly. ½ inch.

and backyard swimming pools are added to the suburban woodland residential area, the deer fly has increasing opportunity to become a pest of man.

These flies have not singled man out as the only source of blood, however, for many warm-blooded animals are suitable hosts. Rabbits in particular are attacked by the *Chrysops*. The intermittent feeding habits of the fly, buzzing from one host to another, provide a means of transmitting tuleremia from animal to animal, and from animal to man. Thus the deer fly must be considered a dangerous, as well as an annoying, pest of man and animals.

Biting House Fly

Much of the house fly's reputation for annoying the Connecticut population really should belong to another fly altogether. This is *Stomoxys calcitrans,* the stable fly, dog fly, or biting house fly. It resembles the house fly, *M. domestica,* in size and coloring, but is readily distinguished by the sharp proboscis projecting out in front of the head (Fig. 10).

Both the male and female flies of this species are vicious biters; and the stabbing pain of the bite may be followed in some individuals by allergic reactions.

Figure 10. *Stomoxys calcitrans,* biting house fly. ¼ inch.

Connecticut is particularly suited to the ecology of this fly because of the variety of available breeding places. Eggs are laid one at a time in decaying vegetables, hay, grass clippings, piles of stable manure, drifts of seaweed along the coast, or pads of algae at the banks of ponds. The larvae hatch in 2 to 5 days and develop over a period of 2 to 3 weeks. Upon completion of larval development in moist organic matter, the larva pupates, or forms a protective shell in which the final development of the adult fly occurs.

This pupal stage lasts for a variable period of time, usually 6 to 20 days. When the adult emerges, it provides a special problem because, like other blood-sucking pest insects, it can transmit diseases mechanically. Undesirable as the biting house fly is, control is difficult. The larvae are not susceptible to DDT, and biological control is expensive. Biological control consists of scattering piles of breeding material so that they dry out and become unsuitable for larval development. This method of control, while effective, is not practical over large areas because of the diverse kinds of available breeding media. It is helpful in restricted areas to rake out and burn old haystacks and piles of grass clippings and to scatter shoreside accumulations of seaweed; in other words, to destroy the larval breeding places.

OTHER FLIES FREQUENTLY ENCOUNTERED

In addition to the flies already mentioned there are a number of species that frequently enter homes and outbuildings or are encountered in the yard and garden. These are often mistaken for house flies by homeowners. While it is not possible to discuss all the Diptera that have been found in the State, some of the following flies are of special interest to the storekeeper, homeowner, and gardener. Information concerning many others may be found in several excellent reference works (4, 5, 6).

Flies in the family Syrphidae, the flower flies, are seldom noticed, except by gardeners, even though they are large and distinctively marked. The species in the family are quite variable in size and shape, but are characterized by the presence of a "spurred" wing vein as shown in Fig. 11.

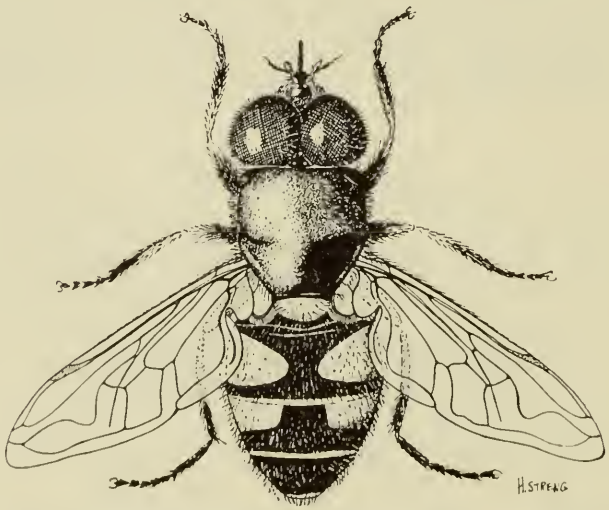

Figure 11. *Tubifera transversus*, syrphid fly. ½ inch.

While some species in the genus *Helophilus* have been reported to cause intestinal myiasis in man, they are relatively uncommon. Perhaps the best known Syrphid in Connecticut is in another genus, *Tubifera*. *Tubifera* (=*Eristalis*) *tenax* is the drone fly (Fig. 11) which develops from the well-known rat-tailed maggot, often found in stagnant water containing organic matter. Homeowners and gardeners encounter this maggot occasionally when they clean decaying leaves out of bird baths, fish pools, clogged gutters, flower tubs, and rain barrels. The larvae develop to about 1 inch in length, and the "rat-tail" (breathing tube) extends as much as 1½ inch beyond the end of the body.

Pollenia rudis, the cluster fly, deserves mention because it frequently comes to the attention of the homeowner in the fall when it enters attics and barns in large numbers. After entering, the flies rest on walls and ceilings in groups, hence the name cluster fly. Although the cluster fly is quite similar to the house fly, it is somewhat larger and the thorax is not striped. The thorax is uniformly colored by a clothing of crinkly yellowish hairs. The larvae of this species are parasites in the bodies of several species of earthworms.

The cluster fly is, as noted above, rarely seen except at the onset of cold weather when, for protection, it swarms in large numbers into buildings. Clusters of them may be found behind picture frames and in corners of walls and ceilings. As the winter progresses, many die and are found on floors near the baseboards. During the winter they are not easily disturbed and are extremely sluggish. When large numbers of cluster flies are present, the accumulation of dead flies in closed places gives off a disagreeable odor.

Small delicate flies in the family Piophilidae are occasionally brought in to public health offices and entomologists for identification, because the flies frequent food-storage places such as kitchens, pantries, and stores and deposit eggs on ham, cheese, bacon, dried fish, and other animal-protein food. When the eggs hatch, the small maggots of *Piophila casei,* the cheese skipper, are readily recognized by their amazing habit of catching the posterior end of their body with the mouthparts. When they suddenly release their hold, the body snaps with a jolt that carries the maggot a considerable distance (hence the name).

Small annoying gnat-like flies in the family Drosophilidae are encountered by almost everyone at some time or another. These small flies, known as fruit flies or vinegar flies, are best known by the species *Drosophila melanogaster* (Fig. 12). These cosmopolitan little flies develop from tiny maggots encountered in old pickle bottles, vinegar pomace, ripe fruits and vegetables, or soured milk bottles. Their size enables them to enter houses through ordinary window screens, so that the fruit fly is almost ubiquitous during the warm weather. Almost any fruit exposed to the air, particularly when it is peeled or has a broken skin, is attractive. The swarm of little gnat-like flies that seemingly appear from nowhere is amazing. The rapid build-up of the fruit fly population is due to the fly's very high reproduction rate and to the extremely short generation time. The short time required for reproduction and to complete development, as well as the ease with which they may be reared in the laboratory, has

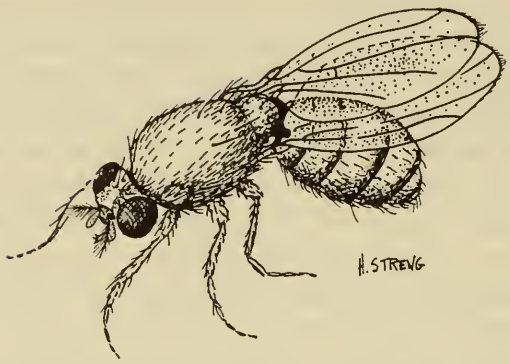

Figure 12. *Drosophila* spp., fruit fly. 1/8 inch.

made the *Drosophila* a valuable tool in experimental genetics and population dynamics studies.

Scenopinus fenestralis, the window fly, is a small black fly about 1/4 inch long. It is slightly humpbacked in appearance, and has a stubby, blunt abdomen. The window fly is noticed in houses, especially during the very early springtime, when the dead flies are found scattered on window sills. The larvae of this fly are of special interest because the slender white maggots feed as predators upon the larvae of cereal and clothes moths. When the window fly is encountered, therefore, it usually means there is a considerable infestation of clothes or flour moths present in the house.

Minute flies in the family Psychodidae are often found dancing against the window pane or dead on window sills in homes and stores. These moth flies or owlet midges generally breed in excrement, decaying vegetables, or polluted water. They sometimes are found breeding, however, in the water of little-used sink and drain traps, and they may emerge from such places in sufficient numbers to become indoor pests. Remarkably, the larvae can live in the polluted water of drains and withstand modern household detergents and cleaning solutions. The adults are small, primitive, almost gnat-like flies, with fringed wings, hence the name moth flies (see also reference 12).

FLIES AND DISEASE

The house fly and related species of blow flies and flesh flies are of medical importance because their feeding habits and flying ability make it possible to transport disease organisms from fecal material directly to man and his food. In feeding, the fly sucks up all kinds of matter in solution and suspension through the large fleshy labella of the proboscis. If the matter contains disease organisms, the food ingested by the fly may contain large numbers of bacteria or enteric viruses. If food for human consumption is the next place the fly visits, the contamination may be deposited in several ways. Some organisms pass through the digestive tract of the fly and are deposited with the feces. When the organisms multiply in the fly's gut, large numbers are deposited, but many do not pass through the fly. The peculiar habit of regurgitating droplets for as long as 24 hours after feeding provides an efficient mechanism for spreading contaminating material. This double-barrelled ability to spread infecting organ-

isms to man's food is not the extent of the fly's ability to spread pathogens. The entire body of the fly is covered with an array of fine hairs and spines to which bacteria may adhere. The sticky fine hairs on the labella and on the legs and the tenet hairs covering the pulvilli (adhesive pads of the feet) make it virtually impossible for the fly to visit contaminated material without subsequently tracking it around extensively.

The transmission of pathogenic bacteria by flies is generally well established and well known. The direct transmission of disease-causing organisms to man is most likely in unsanitary surroundings. Outbreaks of typhoid and dysentery have been attributed to flies transferring bacteria to food. Recent work has shown that the poliomyelitis virus, excreted with feces, may be carried by flies; and naturally infected flies have been found in localities where poliomyelitis epidemics were occurring.

While most of the larvae of flies (or maggots) are free living and develop in decomposing vegetable or animal matter, some occasionally invade the digestive tract where they may exist for a short time (intestinal myiasis). Still others infest wounds where they feed upon exudates and damaged flesh. These are usually the maggots of blow flies and flesh flies which ordinarily feed and develop in decaying animal carcasses. Some of the blow flies also breed in the wool of sheep and so cause serious economic loss.

Occasionally rat-tail maggots of the drone fly, *Tubifera tenax,* which breeds in water containing organic matter, are accidentally ingested by children and cause gastric upset until the larvae are expelled. In such cases the larvae are usually passed in the feces without causing damage.

In Connecticut intestinal myiasis of man is rare, due to the almost universal use of screens to exclude flies, and to proper sanitation in stores and restaurants. Strict regulations by city and state health departments and the modern packaging of food have greatly reduced the incidence of fly infestation and food contamination.

During the past 8 years there has been no confirmed case of myiasis of man in Connecticut. Occasionally fly larvae have been submitted for examination because they were found in soiled diapers or fecal specimens. In these cases the presence of fly larvae was undoubtedly due to the contamination of the specimen by flies after the feces were passed.

BENEFICIAL FLIES

While many of the flies are among our worst insect enemies, other kinds of flies are beneficial to man. Curran (6) states: "If the world should suddenly find itself without flies and bees, it would quickly revert to a sphere lacking animal and plant life, so important are these insects in maintaining the 'balance of nature.'" For example, in the family Syrphidae (the flower flies) almost all the species are beneficial and are second only to the bees as pollinators of plants. In addition, many flies are predaceous in the larval stage and live on plant lice and mealybugs. Of the known species the majority of flies are either predaceous or parasitic on other insects. Large families, such as the Asilidae, Empidae, and Dolichopidae, feed on other insects in the adult and larval stages. One species, *Asilus sadyates,* (Fig. 13) is a large powerful wasp-like fly

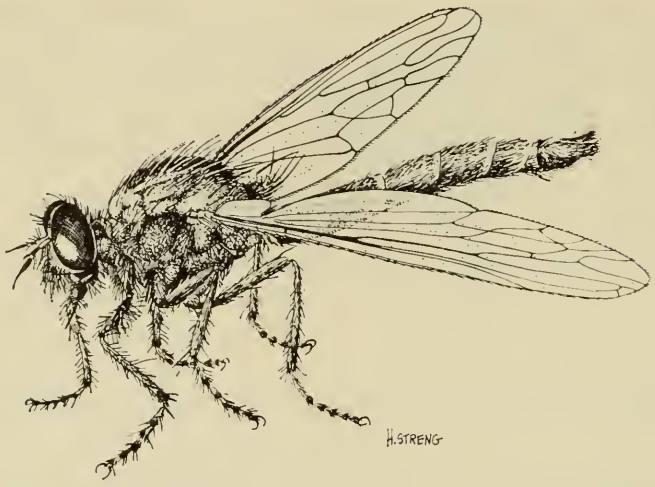

Figure 13. *Asilus sadyates,* robber fly. ¾ inch.

called the robber fly that captures and feeds on other insects. It is often mistaken for a wasp. Others, such as in the families Bombyliidae, Nemestrinidae, Conopidae, and Tachinidae are parasitic in insects and serve as natural control agents.

A fly parasite of the gypsy moth in Connecticut, *Compsilura concinnata,* (Fig. 14) was introduced into this country from Europe over 50 years ago. It attacks more than 140 different caterpillars, many of which are injurious to the New England woodland. During the years of its existence in America this Tachinidae has made one of the most amazing records as a beneficial fly and has spread over a wide geographic area. Another fly that is an effective enemy of Connecticut gypsy moth caterpillars is *Sturmia scutellata.*

Besides pollinating plants and aiding man by conducting biological warfare against insects, some flies are useful as scavengers. Flesh flies and blow flies, particularly, provide larvae that quickly dispose of animal carcasses, decaying vegetation, and animal waste products that would otherwise be unpleasant and detrimental to environmental sanitation. Some of the flesh and scavenger flies in the family Sarcophagidae are also parasites and predators of injurious insect larvae. Some of the genus *Sarcophaga* are effective in cleaning up dead caterpillars where heavy infestations of tent caterpillars and gypsy moths have occurred. One species, *Sarcophaga kellyi* (the grasshopper maggot), is parasitic on grasshoppers in the Western States. One of the important parasites of the tent caterpillar is *Sarcophaga aldrichi,* which attacks both larvae and pupae of the forest tent caterpillar. This fly, when caterpillars are not available, will also breed in carrion and therefore tends to remain in the area when the caterpillars are gone.

PRINCIPLES OF FLY CONTROL

The amazing reproductive capacity of the fly makes possible a rapid population build-up during the warm weather and affords a vulnerable place for man to strike. Therefore, some of the best fly abatement practices in environmental sanitation start with preventing reproduction. Barring

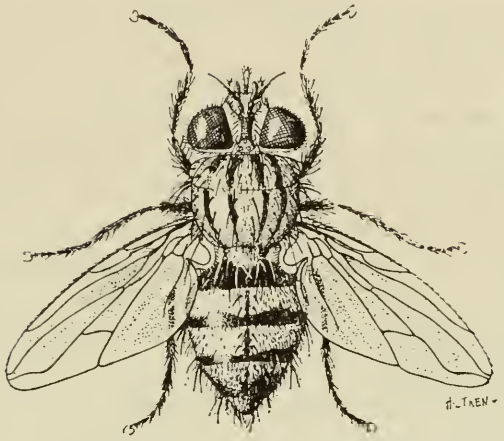

Figure 14. *Compsilura concinnata*, tachinid parasite of gypsy moth larvae. 3/8 inch.

or excluding flies from suitable breeding media, in garbage cans and elsewhere, prevents the gravid female fly from finding a suitable place to deposit eggs. Screen wire and residual insecticides are very effective. If flies cannot be excluded from garbage or decaying plant and animal material, and eggs are deposited, then proper disposal or treatment to kill the immature stages of the fly is necessary.

Advantage may also be taken of certain behavior patterns of adult fly activity. Placing residual insecticides during the warm summer season provides a good example. Since the fly is inactive for several hours during the night, the treatment of outdoor nocturnal resting places is more effective than treatment of indoor sites where the contact is minimal during the period of activity in the daytime. During the cool fall season, however, when the flies no longer rest outside at night, treatment with insecticide indoors is then more effective. Other resting habits of the fly are also important in control procedures. There is a peculiar predilection for resting on edges and projections, such as the corners of window sills and door frames. Twigs at the end of low-hanging branches, bushes, weeds, fences, wires, and edges of buildings that are protected from wind and less than 15 feet above the ground are preferred resting sites for flies. For this reason, the old fashioned sticky fly hangers were particularly effective in trapping flies in stores and houses.

During cool weather, resting places exposed to the sunlight are favorite sites for the fly to rest and bask in the sun. Even during the cold winter months, it has been shown that blow flies regularly come out of hibernation to rest on warm, sunlit walls during the mid-day period (Wallis, 15). Residual insecticides are effective where flies rest, whatever the season.

Prior to the general use of insecticides patterns of fly behavior gave rise to several fly abatement procedures. Many of these are still very effective. Bait traps are useful in restricted areas because of the highly developed olfactory receptors of the fly. Odors of food bait attract flies from a wide radius. Once the flies congregate around the bait, they may be caught in a simple screened box with a conical entrance set up over the bait. Because the flies always move up when they take off from the resting

position, they enter the cone above the bait, and crawl upward through a small hole into the box trap.

In placing traps or insecticide barriers, and in searching for sources of fly infestation in an area, the wind direction is important. Likewise, obstacles to air movement that provide windbreaks must be carefully investigated because of the fly's reaction to air movements.

Storms, hurricanes, and strong winds carry flies down wind. From a localized breeding place they may be widely dispersed down wind. The flies, however, avoid such meteorological disturbances. They seek shelter in any wind break or protected area behind buildings and in dense tree foliage—particularly evergreen trees. When air movements are not unusually swift or gusty, the fly rather than riding downwind on air currents as expected, usually orients itself to move into the wind. Therefore, breeding places that are troublesome in a particular site are likely to be located downwind.

People often ask why there are so many flies in beachside picnic and park areas when there are no obvious breeding places available. On warm days when the prevailing winds from the sea are gentle, the flies move into the wind from inland breeding places. When they reach the shoreline, they simply accumulate in the trees, bushes, and buildings that provide shelter.

A striking example of the relationship between winds, windbreaks, and fly movement was encountered in 1957 in the suburbs of an upstate Connecticut town. A large residential estate was located adjacent to, and upwind from, a poultry farm. A dump behind the farm buildings provided an excellent fly breeding site, although there was no particular fly pest problem on the farm. Around the house and buildings on the neighboring estate, however, the flies were so numerous that outdoor activities had to be discontinued. The owner of the estate reported that he was unable to obtain fly control with insecticide applications and called this Experiment Station for help.

We found that numerous beautiful evergreen trees ornamenting the estate provided the only protective cover for the flies upwind from the breeding place in the dump. The flies moved into the trees around the house faster than insecticides could kill them. A barrier of residual DDT spray applied to the tree line between the house and the dump, and to the dump, was effective in controlling the flies. It was necessary to use only one-tenth the amount of DDT that had been used previously to treat the entire estate ineffectively. Thus a knowledge of fly ecology was put to work in a practical problem of fly control.

Specific methods and insecticides used in chemical control of flies are discussed in the following publications: "The housefly—How to Control This Disease Carrier," by W. E. Britton, C. T. Parsons, and Neely Turner, available from the Connecticut State Department of Health (3); "Insects in Houses," by J. P. Johnson and Neely Turner, from The Connecticut Agricultural Experiment Station, New Haven (11); and "The Housefly—How to Control It," Leaflet No. 390, U. S. Dept. of Agriculture, Washington, D. C. (2).

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